by local government reduced to 7.5% from the previous 25%), textile export recovered and investor regained confidence in buying new machines. The sales began to pick up again in the second half of the year.

Although the shortage of coal and power has relieved and steel price began to drop back, the textile machinery sector was still haunted by price hiking of coal, power, oil and transportation. In the first three quarters of 2011, the power price rose 15%. Under strong competition on market, these costs are hardly offset by increasing selling prices. Therefore, the economic benefits of the sector grew slowly. In the January-September period, the sector produced a profit of CNY 1.5 billion, dropped slightly by 0.37% compared to same period of 2010, with a profit rate of only 4.66%.

The textile machinery sector is highly concentrated in Jiangsu, Zhejiang, Shandong provinces as well as Beijing and Shanghai, which cover 80.73% of total sales. China Textile Machinery Group Corporation earned a sales revenue of CNY 4.83 billion, covering 18.96% of the total, ranking the second place.

Recycled polyester key for Nike

Recycled raw materials play a major role in the latest collection of lightweight, performance sportswear jerseys from Nike, many of which will be worn by several international teams in competitions this summer.

The Nike Pro TurboSpeed suit is said to be the lightest, fastest track uniform the company has ever built and is made with approximately 82% recycled polyester fabric, using an average of 13 recycled plastic bottles for each uniform.

Based on wind tunnel data, it is said to be up to .023 seconds faster over 100m than the previous track uniform and will be used by athletes from the USA, Russia, Germany, and China for international team competitions this summer.

Elsewhere, at five ounces, the new Nike Hyper Elite Basketball Uniform is the company's lightest jersey ever and is made of approximately 96% polyester fabric derived from recycled plastic bottles while the shorts are 100% recycled polyester fabric. Nike said it uses an average of 22 recycled plastic bottles per uniform, which is reflective of its commitment to environmentally-sustainable design.

"Today we've unveiled technology we believe has the potential to change sports performance," said Nike president & CEO Mark Parker. "Nike has always been committed to bringing the best innovations to athletes at every level and we've done that today in a powerful way."

Intertextile offers latest industry innovations & trends

Focusing on China's domestic market, Intertextile Shanghai Home Textiles – Spring Edition, takes place next week from 29 February to 2 March 2012 on the new fairground at the Shanghai World Expo Exhibition and Convention Centre. A record number of participants are confirmed with nearly 300 exhibitors, a 19% increase as compared with last year's figures.

Among them are suppliers from Austria, China, Hong Kong, Korea and Italy. For the first time, suppliers from Shaoxing and Tongxiang will form into special pavilions showcasing their regional expertise, alongside Haining and Yuhang pavilions. Together, these exhibitors will present their latest Spring / Summer collections of curtains, furniture and upholstery fabrics on 37,000 sqm of exhibition space.

This season a debut seminar programme presented by top industry professionals, provides the latest innovations in sustainable development and quality improvement. Among the speakers and topics presented are:

- Resource Saving and Eco-friendly Solutions for Home Textiles by Mr Alex Tai, Chuen Choi, Senior Marketing & Technical Marketing Manager, East Asia, Textile Chemicals for BASF (China) Company Ltd
- Home Textile Market Technical Requirement and Common Quality Analysis by Mr Seeker He, Senior Technical Consultant of softlines for SGS-CSTC Standards Technical Services Co Ltd
- Botanic softness with Lenzing Modal by Ms Carls Susanne and Ms Lucia Chen, Marketing Hometextile for Lenzing AG and Lenzing Fibers (Shanghai) Co Ltd

In addition, the Spring fair will set up a unique interactive Trend Introduction Tour where attendees can find home textile and colour trends forecasted by China Home Textiles Trends Research and Extension Atelier.

Intertextile Shanghai Home Textiles Spring is organised by Messe Frankfurt (HK) Ltd, the Sub-Council of Textile Industry, CCPIT and the China Home Textile Association (CHTA).

57 companies assessed by SAM, among which were three in the Gold Class, three in the Silver Class and two including Teijin in the Bronze Class. Teijin also is listed in the Dow Jones Sustainability World Index and the Dow Jones Sustainability Asia Pacific Index.

Together with two subsidiaries of Asahi Group holdings, Teijin recently launched what is says is the first closed-loop recycling system in China for polyester uniforms. In collaboration with Shandong Asahi Green Source Hi-Tech Farm Co., Ltd. and Shandong Asahi Green Source Milk Products Co., Ltd., both subsidiaries of Asahi Group, Teijin is using its 'Eco circle' closed-loop recycling system to chemically recycle uniforms — a first for China.

The move marks a new milestone for Teijin which says it is already working with more than 150 apparel and sportswear manufacturers worldwide to develop and manufacture products made from recyclable materials, as well as to collect and recycle these products at the end of their useful lives. These include well-known brands such as Patagonia Inc., Henri Lloyd and Quiksilver Europe. In China, Teijin has been collaborating with Li Ning, the nation's largest sports apparel brand, since 2009.

Teijin says that repeated recycling achieved with the 'Eco Circle' system significantly reduces both energy consumption and carbon dioxide emissions compared to conventional petroleum-based processes for polyester production.

Turkey`s ITM Texpo Eurasia and HIGHTEX 2012 to raise curtain this April

To be held during April 21-24 in Istanbul, Turkey, the fourth edition of the International Textile Machinery Exhibition (ITM) will be joined with the yearly Texpo Eurasia International Textile, Weaving, Yarn, Finishing, Knitting, Hosiery Machines, Side Industries and Chemicals Exhibition under the umbrella of "ITM Texpo Eurasia 2012". HIGHTEX 2012 Technical Textiles and Nonwovens Exhibition and Istanbul Yarn Fair will also be concurrently held

The ITM Texpo Eurasia 2012 Exhibition is expected to be an exhibition visited by the Turkish textile manufacturers as well as visitors from the surrounding and neighboring countries. They will see cotton and fiber preparation, yarn preparation, yarn twisting, weaving preparation and weaving, flat and circular knitting, quilting, hosiery, embroidery, dyeing-printing-finishing machineries, textile chemicals, laboratory equipment and quality control systems, CAD- CAM- CIM application and automation systems, machinery spare parts and accessories at the exhibition

On the other hand, at HIGHTEX 2012, all related technology, raw material, chemicals and semi-products and end-products related with technical textiles and nonwovens will be presented.

The organizers say that previous ITM's were participated by exhibitors from the US, Germany, Austria, Brazil, Belgium, the Czech Republic, China, Denmark, France, Holland, India, the UK, Spain, Israel, Sweden, Switzerland, Italy, Iran, Japan, Korea, Luxembourg, Egypt, Pakistan, Singapore, Turkey, Greece and Taiwan. For this year, more than 50,000 visitors, mainly coming from Middle East countries as well as the Balkans and African countries, are expected.

According to the organizers, Turkey continues to be the location of interest in the international arena with its potential, experience, know-how, qualified human force, production capacity, quality, development in RandD and PandD studies, etc.

China - Sales of textile machinery maintained growth in 2011

In the first three quarters of 2011, the sales of textile machinery and equipment amounted to CNY 29.95 billion, up 10.44% year-on-year. The textile machinery realized a total profit of CNY 1.5 billion, down 0.37%. The pre-tax profit stood at CNY 2.69 billion, up 6.26%. The per-capita profit dropped moderately by 2.73% compared to the same period of 2010.

The setbacks encountered during the operation of textile economy, especially textile trade disputes and tariff barrier, have exerted negative effects on investors´ confidence. As a result, both production and sales of textile machinery had declined. As trade disputes being solved and export refund policy adjusted (export refund bore

Although these support industries enjoy exemption from paying duty on import of raw inputs for production and scientific research, they are still in a fragile state as they need to import about 80 percent of their raw material requirements from other countries.

This, he said is hindering the country's economic growth, as the country needs to spend billions of dollars for imports. Hence, he urged the Government to implement appropriate measures to support the country's textile and garment industry and to reduce its dependence on imports.

Use of Azo dyes can harm Pak textile exports

Pakistani textile exporters have expressed concern that use of banned Azo dyes in processing textiles and leather items can endanger the brightening prospects of textile exports to the European Union nations.

Azo dyes are usually used in colouring textiles and leather, but some of these dyes have a tendency of emitting aromatic amines that pose cancer threat.

Shabir Ahmed, Chairman of Pakistan Bedwear Exporters Association (PBEA) revealed that several members have complained regarding the use of banned Azo dyes by some of the textile processing mills.

He informed that PBEA is planning to constitute an inquiry committee to identify such millers who are endangering the country's exports by utilising such dyes which are banned across the globe, as though being low-priced these are harmful to human health.

EU and several other developed nations have formed laws restraining exposure to these harmful amines, which means that Azo dyes emitting aromatic amines cannot be used for dyeing textile and leather goods that get into direct contact with skin, Mr. Ahmed said.

He cautioned that the use of Azo dyes is a serious issue that needs to be addressed promptly before the same being noticed by foreign buyers, as it may then cause an irretrievable harm to the nation's economy.

Bangladesh to boost silk yarn production

The Bangladesh Sericulture Board (BSB) is trying to widen its sericulture programme in order to increase silk yarn production in the country.

Speaking to fibre2fashion, Mr. Sunil Chandra Pal, Chairman of BSB, said, "The current demand for silk yarn in the country is about 300 tons, whereas the local production is only 50-60 tons.

Explaining the reason behind low production of silk yarn in Bangladesh, he says, "The production costs and market prices are not competitive. Hence, the sericulturists are not interested to produce silk."

Briefing about the steps being taken to boost silk yarn production, he avers, "Initially, we wish to increase the production to a level where it can at least meet the local demand. We are planning to expand our sericulture programme throughout the country so that we can motivate farmers to undertake silk production."

"Currently, the price of imported silk yarn is increasing and hence sericulturists have started showing interest in producing silk yarn," he reveals.

Informing about the role of silk industry in the country's economy, the BSB Chairman says, "Currently, around 600,000 people are engaged in the silk industry, out of which there are 50,000 cultivators. The locally produced silk products are consumed only in the local market. Most of the silk product manufacturers do not produce any export items. The contribution of the silk industry to the national economy is very minimal because of the low production."

Teijin named on sustainability list

Teijin Limited has been named in the Bronze Class of The Sustainability Yearbook, one of the world's best-known corporate-sustainability publications issued by the Swiss-based SAM Group.

Each year, the world's 2,500 largest companies in the Dow Jones Global Total Stock Market Index are invited to participate in SAM's Corporate Sustainability Assessment. The Yearbook lists only the top 15% of the companies in terms of economic, environmental and social performance in each of 58 industrial sectors.

The 433 companies listed this year were ranked in three classes – Gold, Silver and Bronze – along with separate awards to sector leaders and sector movers. The Yearbook's chemical sector listed 17 companies out of the

World Textile News

USDA presents world cotton outlook for 2012/13

US Department of Agriculture's (USDA) world cotton outlook shows stocks rising in 2012/13 for the third consecutive season, largely as a result of continuing market and policy repercussions from the record cotton prices of early 2011.

World production for 2011/12 has reached a record 123 million bales, as output expanded in nearly all cotton-producing countries except the United States. At the same time, world consumption has fallen sharply—by 4 percent for the second consecutive season--due not only to macroeconomic uncertainties, but also to substantial shifts from cotton to polyester in textiles.

And perhaps most problematic for the 2012/13 projections, China's government has responded by supporting domestic prices well above world market-clearing levels, in an effort to create buffer stocks for protection from future price volatility. The China government-owned reserve is expected to hold about one-fourth of world stocks on July 31, 2012.

World production is projected to fall and consumption to rise in 2012/13, but supply is still expected to exceed demand, raising stocks further and pressuring prices. Early season projections are inherently uncertain due to the difficulty of predicting market and weather developments.

However, for 2012/13, these uncertainties are exacerbated by the unknowns associated with the further accumulation and/or release of reserve stocks by China. Since China's policies affecting the 2012/13 season have not been announced, this paper assumes a continuation of the current floor price, with reserve release as needed to rotate stocks and provide adequate supplies to mills in the pre-harvest periods of 2012 and 2013.

Experts urge Vietnam govt to support garment industry

The Vietnamese Government has been urged to support the country's textile and garment industry by providing tax holidays, financial support and also by implementing policies to boost the sector's growth.

Speaking at a seminar organized by the Financial Policies and Strategy Institute and the Institute for Industry Policy and Strategy, Ministry of Finance's Duong Thi Nhi said the Government should concentrate on textiles, garments and other industries that enjoy several natural advantages, but still are not in a very good state.

Citing an example, he said, textile and garment exports from Vietnam were valued at US$ 6.16 billion during the initial six months of 2011, against which its imports, mainly comprising of raw inputs and accessories were valued at US$ 5.76 billion. Thus, the industry's net export value was just US$ 400 million.

Institute of Finance's Dr. Nguyen Thi Lan said the Government has created favourable atmosphere for investment in six specified sectors, called support industries, by both domestic as well as overseas investors.

tured Coating Company (manufacturer of sputtering apparatus) and Middle East Bio-Researchers (producer of ethylene adsorbents used to improve the preservation of agricultural crops).

In addition, the Iranian fabricated version of the anticancer drug Doxorubicin HCl, which has been proved to be effective in treatment of a wide spectrum of cancers, was put on display in Nanotech 2012.

Of other participating countries of the event mention can be made of Belgium, Canada, Germany, South Korea, Finland, Spain, Switzerland, Taiwan, Czech Republic, Britain and the US.

Concurrently with the opening day of Nanotech 2012, Asian Nano Forum (ANF) members took the opportunity to hold a meeting with the Iranian representatives in attendance. Also, a seminar focusing on Iran's capabilities and growth in nanotechnology is arranged to be delivered on the last day of Nanotech 2012.

The Japan Nanotechnology Exhibition is marked as the world's biggest and most prestigious exhibition in the field and has been held consecutively for eleven years. The Islamic Republic of Iran is currently attending this significant event abreast other pioneering countries like the previous five editions.

Iran to increase oil export to China to 500,000 bpd in 2012

The National Iranian Oil Company (NIOC) has reached an agreement with the International United Petroleum and Chemical Corporation (UNIPEC) to increase oil exports to China to 500,000 barrels per day (bpd).

The agreement with UNIPEC, indicates that a decline in Iranian crude exports to China earlier this year was due to a commercial dispute rather than political reasons, Dow Jones Newswires reported.

According to the report, the deal is another sign that China has no immediate plans to obey US sanctions, which were toughened late last year to increase pressure on Iran over its peaceful nuclear activities.

On the New Year's Eve, the US President Barack Obama signed into law new sanctions which aim to penalize other countries for dealing with Iran's central bank and importing its crude oil.

The European Union also banned Iran oil imports by its members on January 23.

Major Asian oil consumers, China, India, and South Korea, along with Iraq and Turkey have already asked for waivers on US oil sanctions against Iran.

Although the terms of the new contract between NIOC and UNIPEC have not been made public, last year's contract was for 220,000 bpd of crude and 60,000 bpd of condensate from Iran's South Pars gas field.

Iran's deputy oil minister headed a delegation to China this week to negotiate a new crude supply contract and other joint projects in oil, gas and petrochemicals with Beijing.

The new agreement comes following those negotiations and is expected to increase Iran's oil shipments to China to above 500,000 barrels a day in 2012.

During a briefing in Washington on February 14, China's Deputy Foreign Minister Cui Tiankai dismissed US-led sanctions on Iran to force the Islamic Republic into freezing its peaceful nuclear program, stressing that Beijing intends to pursue its "legitimate economic interests" with Tehran.

The United States, Israel, and their allies accuse Tehran of pursuing military objectives in its nuclear program with Washington and Tel Aviv repeatedly threatening Tehran with the "option" of a military strike against its atomic facilities.

Iran argues that as a signatory to the Nuclear Non-Proliferation Treaty and a member of the International Atomic Energy Agency, it has every right to develop and acquire nuclear technology for peaceful purposes.

Iran Textile News

Iran`s fear of halting supply to Europe sends pricesup

Crude oil futures rose on Friday, snapping a week of losing streak, as a surprise surge in US jobs for January added to recent signs of improving economic growth and raised hopes for better oil demand going forward.

Unemployment rate drops to near three-year low implying that the US economy created jobs at the fastest pace in nine months in January, Labor Department data showed.

The positive economic outlook added to early gains triggered by a warning from Iran that the country would retaliate against the West for imposing sanctions on the Islamic Republic over its nuclear program.

However, prices were down for the week, pressured by midweek inventory data which showed a higher-than-expected rise in domestic oil stockpiles and an unexpectedly large increase in gasoline inventories.

The situation in the Middle East remained in the markets; key focus area.

The U.N. Security Council would meet this weekend to vote on a European-Arab draft resolution endorsing an Arab League plan calling for Syrian President Bashar al-Assad to give up power.

On the New York Mercantile Exchange, crude for March delivery settled at US$97.84 a barrel, losing US$7.72 week on week. Brent crude for March rose US$4.08 2to settle at US$114.58 a barrel and posted a 3.5% weekly rise.

Iran Presents Technological Capabilities at Nanotech 2012 Exhibition

Japan Nanotechnology Exhibition, Nanotech 2012, was inaugurated at Tokyo International Exhibitions Center on February 15th with six companies from the Islamic Republic of Iran actively participating in the event, for the fifth consecutive year.

The mentioned Iranian participants are as follows: Payamavaran Nanotechnology Fardanegar (manufacturer of nanomaterials synthesis equipment), Fanavaran Nano-Meghyas (manufacturer of electrospinning and elecrophoresis equipment), Nanotechnology System Corporation (NATSYCO) (manufacturer of STM and AFM microscopes), Iran Riff Company (producer of nano paints), Nanostruc-

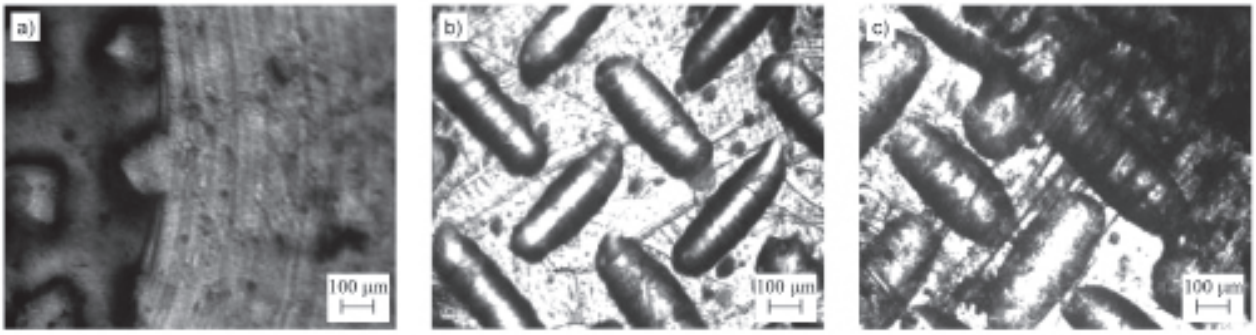

Figure 17. *Topography of prints of 1.8% SiC composites on polyester film, a) unultrasonicated print after 30 min under a load of 2 N, b) ultrasonicated print after 10 min under 5 N, c) ultrasonicated print after 30 min under 5 N.*

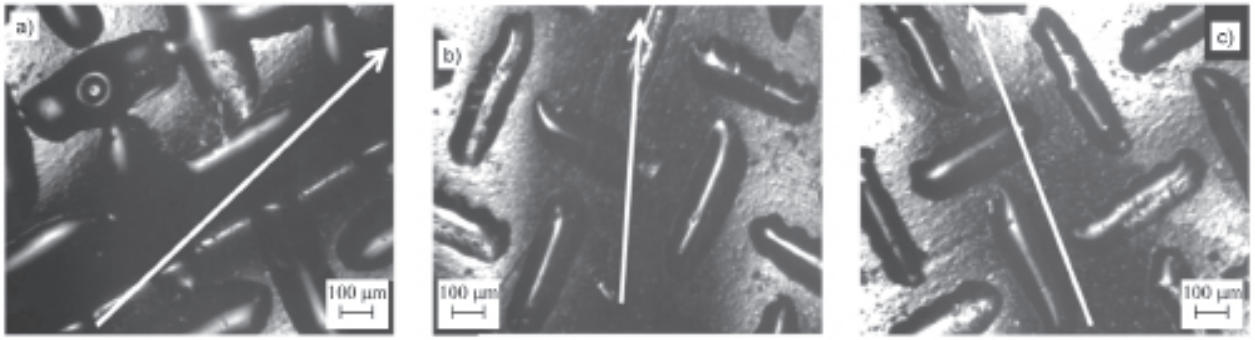

Figure 18. *Topography of prints (arrows indicate yarn travel direction) on polyester film made of: a) paint, b) 1.8% SiC unultrasonicated composites, c) 1.8% SiC ultrasonicated composites.*

longer times and higher loads were not performed. The friction force was stable in these tests, thus no significant wear phenomena occurred. As in microtribometer tests, only minor layer destruction occurs during tests of these compositions, which does not impair their protective function.

Topography of wear traces after yarn tensioner tests

Topography of prints on polyester film after yarn tensioner tests is shown in ***Figure 18.***

The wear trace is visible in the form of a dark stripe along the yarn travel direction and is most pronounced on the unmodified paint print. The addition of SiC without dispersion enhancement results in a somewhat less distinct trace, and almost no visible destruction is seen in prints with ultrasonificated SiC nanoparticles.

It should be also noted that pyrometric measurements carried out during the tests indicated no temperature increase at the friction point. The yarn temperature was 18 °C, either before or after the friction point. The sample surface temperature also remained constant. Given that in real yarn tensioners yarn is forced into transversal movements on the bag surface, this allows to expect that the temperature increase may be well within the layer heat resistance limit in these applications.

Summary and conclusions

A novel antiwear protective layer has been designed in the form of a discontinuous pattern of regularly spaced epoxy nanocomposite islands of micrometer range size. Very effective nanofiller dispersion in paint was achieved by applying high power density ultrasonification using the solvent procedure. The addition of SiC nanofiller, in concentrations ranging from 1.0% wt. to 3% wt. strongly influences wear properties of the nanocomposite layers investigated. Effective antiwear protection of model substrates by these nanocomposites was demonstrated under laboratory test conditions. The best antiwear properties were observed for the 1.8% wt. SiC share, which was further confirmed in the high load experiments and in a real working environment.

Editorial note

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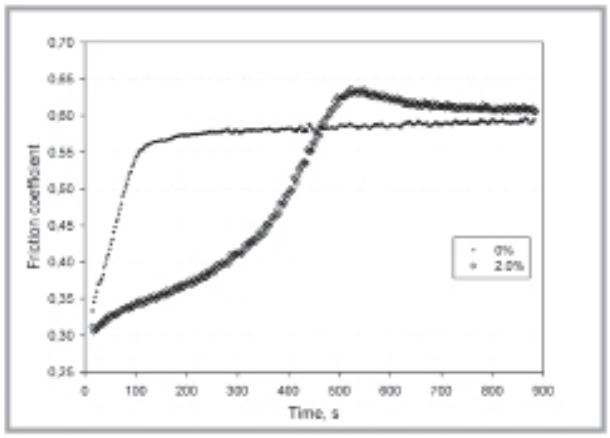


Figure 11. *Friction coefficient of a 2.0% wt. SiC continuous layer, printed on silicon wafer, versus the test time.*

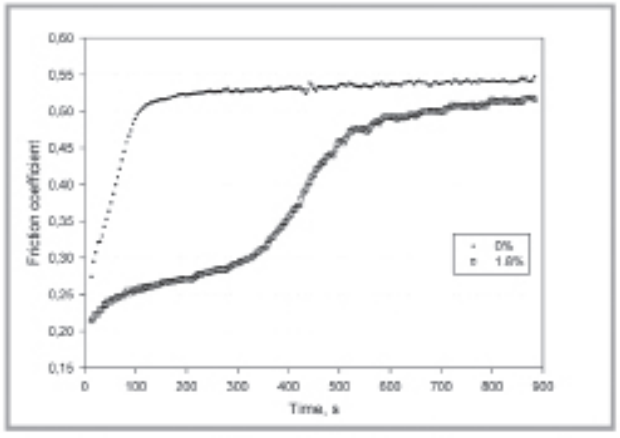


Figure 13. *Friction coefficient of a 1.8% wt. SiC continuous layer, printed on silicon wafer, versus the test time.*

obtained in these tests are shown in ***Figure 12***. The longest time to reach a plateau was obtained for the 1.8 % wt. SiC composition, shown separately in ***Figure 13***, which composition was chosen for further, high load testing involving the Ball-on-Disk tribometer and experiments in application conditions, using the yarn tensioner.

Topography of wear traces after microtribometer tests

To further evaluate the wear of nanocomposite layers, the topography of wear traces was investigated using optical and atomic force microscopy. In ***Figure 14***, the wear trace in a 1.8% wt. SiC printed continuous layer after a microtribometer test is shown. The total layer thickness is approx. 10 μm, as measured with optical microscopy. ***Figure 14.a*** shows that although the outmost layer was removed during the test, the continuity of the layer is preserved. In other words, even though some wear occurs during the test, the layer fully maintains its protective ability.

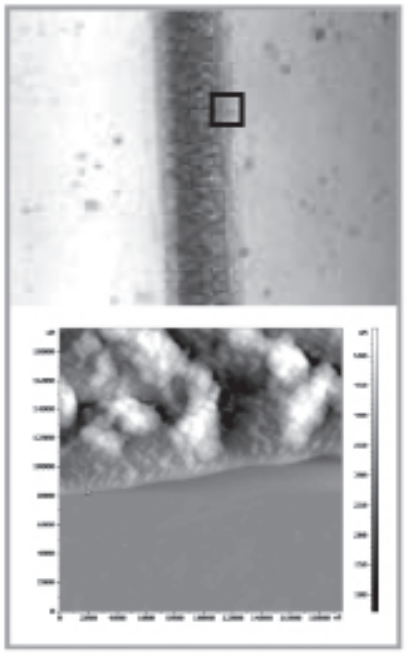


Figure 14. *Topography of the wear trace in a1.8 % wt. SiC printed continuous layer, after a microtribometer test, a) optical microscopy, b) AFM, blow-up of the area selected in a).*

Partial wear is also shown in ***Figure 15*** (for 1.8% SiC wt. nanoc omposite printed patterns). It can be seen that the nanocomposite "islands" undergo some plastic deformation but remain attached to the substrate, which demonstrates their good adhesion to the substrate.

Topography of wear traces in 1.8% SiC composites after ball-on-disk tests

Ball-on-disk tests were performed on printed patterns of the 1.8% SiC composites to evaluate their wear behaviour and topography of wear traces after wear tests in the newton scale. A comparison was also made between composites prepared using high power ultrasonification and those prepared without dispersion enhancement. Increasing loads and test times were employed until layer disruption was seen in the topography examination, except for samples which did not reach that point under reasonable test conditions.

Prints of unmodified paint on polyester film, shown in ***Figure 16***, survive under a load of 2 N for up to 30 minutes. The addition of 1.8% wt. SiC with no dispersion enhancement does not significantly change the layer wear resistance (***Figure 17.a***).

The application of high power density ultrasonification, however, changes the situation significantly – the print remains intact for 60min under a load of 2N (not shown here). The first wear traces are only visible after 10 min under a load of 5N, and even after 30min under such a load the pattern is still present on the substrate surface (***Figure 17.a and 17.b***).

It is important to note that the loads applied in these tests far exceed loads that will act on bag walls in yarn tensioner applications. Therefore, tests employing

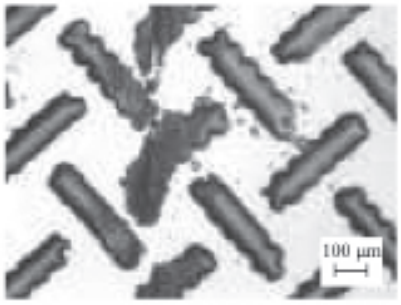


Figure 15. *Topography of a 1.8 % wt. SiC printed pattern, after a microtribometer test.*

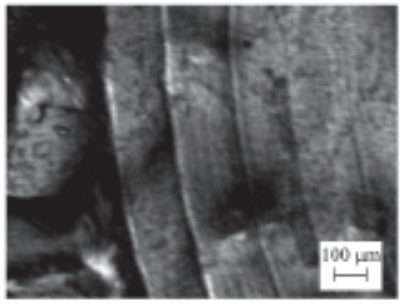


Figure 16. *Topography of a paint print on polyester film after the ball-on-disk test, after 30min under a load of 2N.*

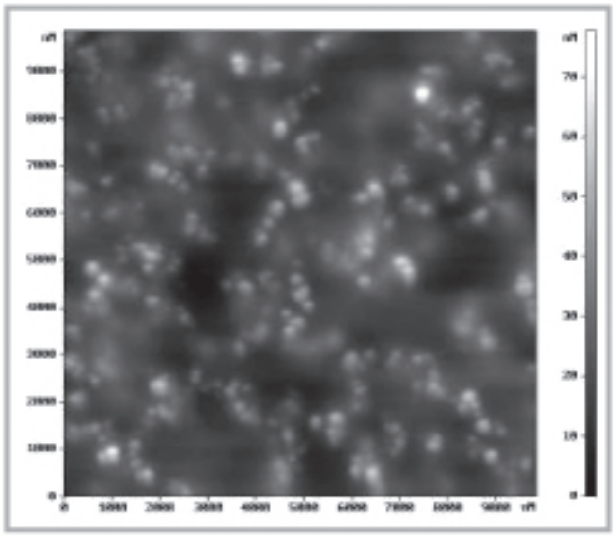


Figure 8. *Topography (AFM) of the printed continuous layers with 2% wt. SiC.*

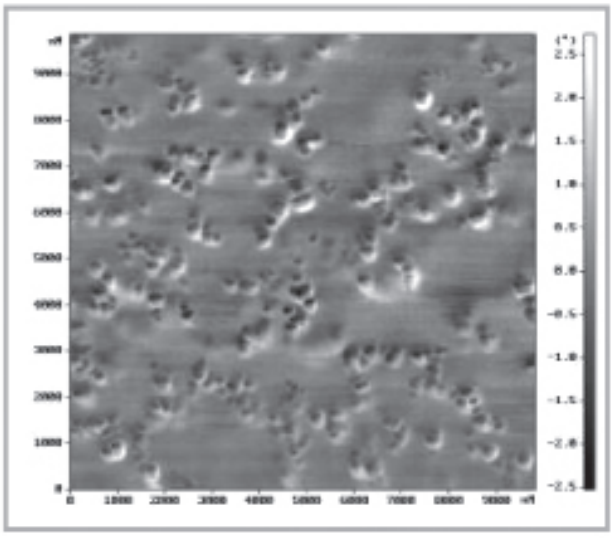


Figure 9. *Phase contrast image of the printed continuous layers with 2% wt. SiC.*

wherein the screen with no pattern was used, as described in the subchapter 'Silk screen printing' Nanocomposites containing SiC particles in the range of 1 - 3% wt. were printed on silicon wafers and polyester films. The film surfaces were investigated using an optical microscope and AFM. Compared to dip coated layers, some more particle aggregation occurs in the printed layers, as can be seen in ***Figures 8*** and ***9***. This can be attributed to shear forces resulting from pressing the composite through the screen mesh during printing. Nevertheless, the dispersion is still extremely satisfactory in these composites.

Composite optimisation

A series of laboratory scale wear and friction tests under loads in the millinewton scale were performed to relate the wear properties of the composites to their composition and to select a composite with the best wear resistance – for further, more severe, application related testing. Most tests were performed on printed continuous layers. In the case of printed patterns, the results were more difficult to interpret due to the layer discontinuity interfering with the friction force readout. The tests were performed primarily to investigate wear trace topography.

In the experiment, the friction force versus time and sample displacement was acquired. Experimental records were statistically elaborated, excluding extreme data, to calculate the friction coefficients for each up and down cycle. Plots of the friction coefficient versus the overall test time, equivalent to the number of cycles, are shown in ***Figure 10***, for the different SiC contents. For comparison, plots for unfilled paint prints are also shown. As the wear of the sample surface progresses, more debris is produced, manifested by the increase in the friction coefficient. The important feature on these plots is that the time of reaching a plateau indicates the wear resistance of the sample.

The wear resistance of the paint is not affected by the addition of up to 1.5% wt. of SiC nanoparticles, but it significantly increases at 2.0% wt.; however, it decreases again with a further increase in the SiC content. A separate plot for the composition with the best antiwear properties is provided in ***Figure 11*** for clarity.

In order to precisely determine the composition for which the best wear resistance is achieved, a series of tests were performed on composites with a narrowed SiC content range of 1.6-2.4% wt. The friction coefficient versus time plots

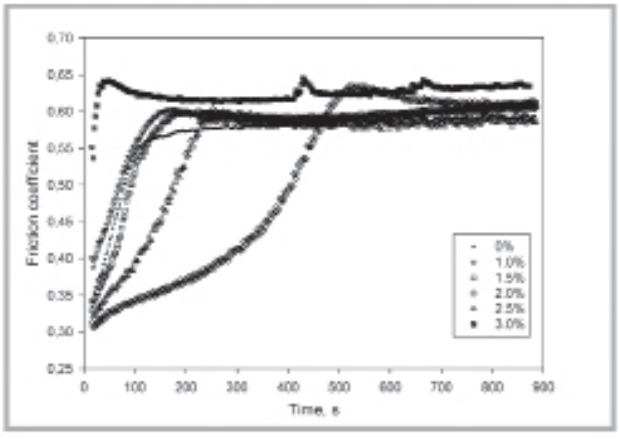


Figure 10. *Friction coefficient of continuous layers vs. test time, 1 - 3% wt. SiC*

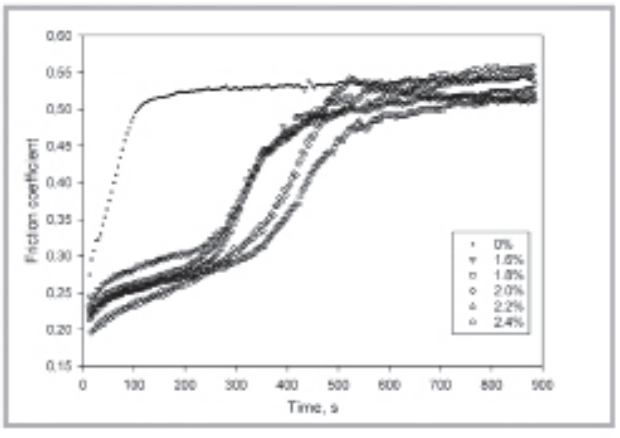
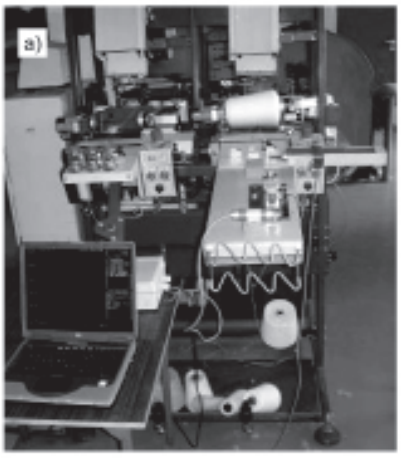


Figure 12. *Friction coefficient of continuous layers vs. test time, 1.6 - 2.4 % wt. SiC.*



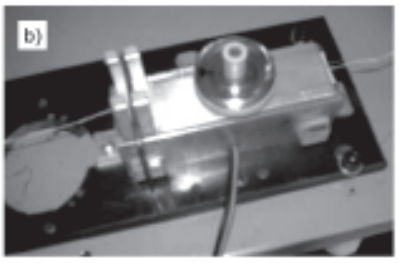


Figure 5. *Yarn winding testing rig: a) overall view, b) yarn tensioner with new elastic damping system.*

technology, Radom, Poland [4, 5]. The device consists of a control and a testing block. The control block is a computer-based unit, with four channels of data acquisition, computerized motor controllers for motion in the x and y-directions, and a system of normal load application. The microtribometer can provide linear motion with a speed ranging from 2 to 2000 μm/s. A normal load, which can be applied during frictional tests, covers the range of 1 – 1000 mN.

Tests were run under a load of 450 mN, at room temperature. The counterpart used was a steel ball with a diameter of 10 mm, moving up and down in 100 cycles at a velocity of 2 mm/s, for a distance of 7 mm. At least three runs were performed for each SiC concentration investigated.

High load and 'real life' tests on the selected composite

Wear and friction tests in the newton scale

Wear tests of continuous layers and patterns in the Newton range of loads were performed using a ball-on-disk tribometer (model T-11) [4], made by the Institute for Terotechnology, Radom, Poland. Measurements were carried out during frictional contact created by a rotating disk with a sample on it, and a ball pressing against it. The samples were taped to the disk. The disk and ball were made of steel. Tests were run under loads of 1 N, 2 N and 5 N, at room temperature; test times were 60 s, 600 s, 1800 s and 3600 s. The sliding speed was 0.01m/s. Before and after each test, the ball and the disk were washed with chloroform to remove any wear products. After the tests, the samples were collected for evaluation of wear traces.

Yarn tensioner

Laboratory tests conditions are far from those present in the application environment of textile machines – the counterpart is steel not yarn, the magnitude and dynamics of the load are also significantly different. Additional tests were, therefore, conducted on selected nanocomposites, utilising a real yarn tensioner setup [6, 7], enhanced with several control and acquisition features allowing to precisely monitor yarn tension dynamics. The yarn winding testing apparatus, shown in ***Figure 5***, was developed at the Institute for Terotechnology, Radom, Poland.

The composite prints on the polyester film substrate were glued to an elastomeric bag filled with a non-Newtonian fluid and placed in the tensioner. The tests were conducted under the following conditions: a yarn tension of 60 cN, a yarn travel velocity of 1000m/min, and a test time of 5 min. After the tests, the samples were collected for evaluation of wear traces.

Microscopy

Dispersion SiC particles in the paint matrix were evaluated by means of atomic force microscopy (AFM), with a NT-MDT Solver system, operating in the tapping mode, using the Si/SiO_2 tips. Plasma etching was applied for 5 minutes before the measurements to expose SiC particles near the surface.

Wear traces on the surfaces of the samples after the wear and friction tests were investigated using an optical microscope.

Results

Investigation of dispersion

SiC dispersion in continuous nanocomposite layers

The deposition of continuous layers on model substrates using the dip coating technique allowed to obtain flat, smooth layer surfaces, suitable for atomic force microscopy. AFM was used for investigation of SiC dispersion in the matrix. The effectiveness of the ultrasonification procedure applied was thus evaluated in comparison with composite preparation with no dispersion enhancement. As shown in ***Figure 6***, high power density ultrasonification proved to be very efficient in deagglomerating and dispersing SiC in the paint. Separate nanoparticles can be seen homogeneously distributed, their height being of about 10 nm.

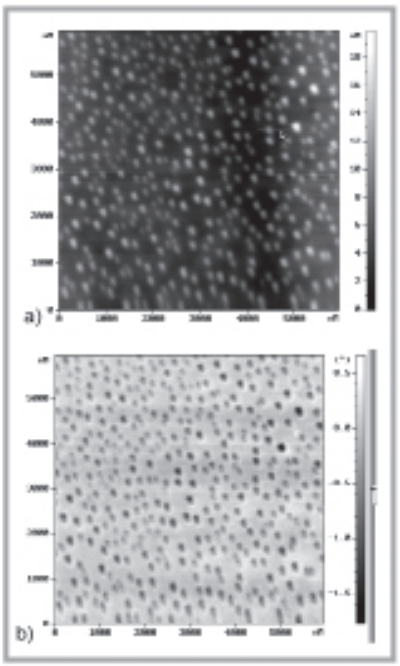


Figure 6. *SiC nanoparticles in continuous layers containing 3% wt. SiC, dip coated on polyester films: a) topography, b) phase contrast.*

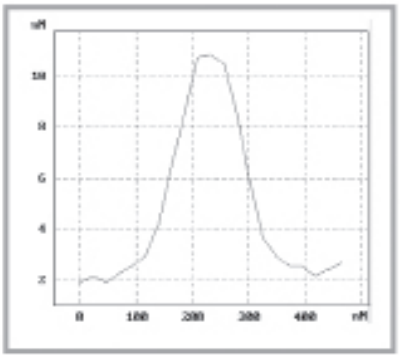


Figure 7. *Distribution of nanoparticles in the cross-section.*

Topography of printed continuous layers

To evaluate the influence of the printing process on SiC dispersion, continuous nanocomposite layers were also prepared using the silk screen printing method,

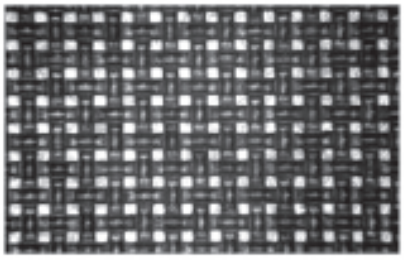


***Figure 2**. Silk screen printing with no pattern applied, used in this work for printing continuous layers.*

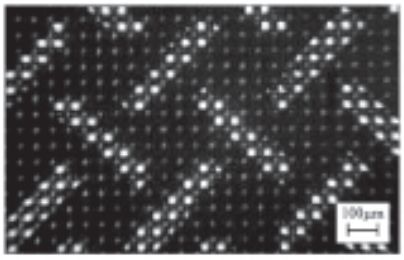


***Figure 3.** Pattern on the screen, made of uncovered mesh of the net, used in this work for printing noncontinuous layers.*

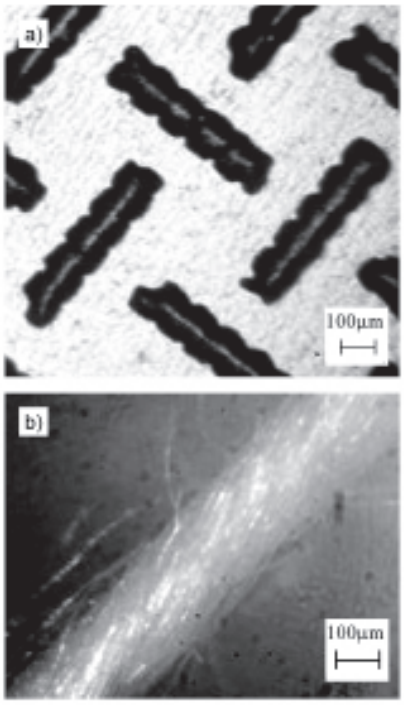


***Figure 4.** Comparison of sizes of the nanocomposite pattern and a typical yarn: a) 2% wt. SiC pattern, printed on polyester film. b) yarn shown at the same magnification.*

adding a hardener. Three experimental routes then followed: SiC investigation of the dispersion in the paint, composition optimisation and high load and 'real life' tests on the composite selected. In the first route, silicon wafers and polyester films were dip-coated with nanocomposite continuous layers to obtain samples for the investigation of the SiC dispersion in the matrix. In the second route, silk screen printing of nanocomposite continuous layers and patterns onto model substrates was performed to investigate and optimise the influence of the SiC concentration in the composite on its topography and wear properties in laboratory conditions. More severe wear tests corresponding to application conditions were performed on the optimised composite in the third step.

Preparation of SiC dispersions

For the initial evaluation of the dispersion, SiC nanopowder was manually mixed with the lacquer and hardener, with no additional dispersion enhancement, to obtain composites with an SiC content of 2% wt. For extended studies of the dispersion and for mechanical experiments, ultrasonification was applied to enhance the dispersion of SiC in the matrix. The SiC nanopowder was deagglomerated and distributed in tetrahydrofurane solution of the paint using a Hielscher UP200S high power density ultrasonic processor, operating at an acoustic power density of 80 W/cm^2. SiC deagglomeration was initially carried out in pure solvent with some detergent, then portions of the paint were subsequently added. The whole process took 30 minutes and 60 minutes in the case of samples prepared for dip coating and silk screen printing, respectively.

Adequate cooling of the mixture was provided during ultrasonification to avoid solvent boiling. After ultrasonification, tetrahydrofurane was evaporated in a rotary evaporator and the hardener was added to the mixture to obtain an appropriate viscosity for printing. The SiC concentration in the resulting composite was 3% wt. in samples prepared for dip coating. For silk screen printing, two batches of samples were prepared, with an SiC content of 1 - 3% wt. for preliminary wear and friction tests and 1.6 - 2.4% wt. for fine tuning the composites on the basis of wear and friction tests results

Dip coating

To facilitate investigation of SiC dispersion in paint, continuous nanocomposite layers were deposited on model substrates: silicon wafers and polyester films, by means of the dip coating procedure. Prior to use, the substrates were cleaned with methyl alcohol, after which low temperature RF plasma treatment was applied for 10 minutes to further clean the substrate surfaces. All nanocomposite layers were deposited under the same conditions, using a coating speed of 25 mm/min, at room temperature. Reference samples of pure paint were also prepared. To achieve full crosslinking of the matrix, the samples were heated to 60 °C and maintained at that temperature for 24 h.

Silk screen printing

In the silk screen printing procedure, a pattern created on a screen is reproduced on a surface by pressing paint with a squeegee through the screen against a substrate [3]. The screen is made of a net stretched on a frame, and the pattern is applied by photochemically covering selected parts of the screen. The screens used in this research are shown in ***Figure 2***. Such screens with no pattern applied were used in this research to print continuous layers for wear and friction tests in the millinewton scale. The pattern designed for the screens consisted of regularly spaced rectangles of 100 × 400 µm, as seen in ***Figure 3***.

As stated above, two batches of composites were used for silk screen printing: 1 - 3% wt. and 1.6 - 2.4% wt. The pattern was very precisely reproduced on substrate layers by painting nanocomposite cuboids of 100 × 400 × 10 µm, as can be seen in ***Figure 4.a.***

The pattern spacing was dense enough to ensure the smooth transport of yarn on top of the layer (***Figure 4.b.***), at the same time providing enough room for layer deformation.

Wear and friction tests in microscale

Investigating the antiwear properties of the nanocomposite materials developed, frictional tests in the millinewton scale were performed with continuous layers printed on model substrates, as described above. The principal goal of these experiments was to evaluate the properties of nanocomposite material itself but not the pattern, therefore continuous layers were used instead of patterns to eliminate any geometrical effects that might interfere with the friction force readout. The samples were frictionally tested on a reciprocating ball-on-flat machine, developed by the Department of Chemical Technology and Environmental Protection, University of Lodz and the Tribology Department of the Institute for Tero-

Elastic Yarn Tensioner with a Noncontinuous Antiwear Nanocomposite Pattern

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Abstract
Continuous hard protective layers on soft substrates working under elastic deformation conditions are prone to uncontrolled cracking and detaching from the substrate during bending and straining. Implementation of a noncontinuous hard pattern deposited on the surface allows such an antiwear layer to freely deform with the substrate. The idea was demonstrated for patterns made of regularly spaced, micrometer range sized nanocomposite islands. The nanocomposite used consisted of an epoxy resin matrix and superhard silicon carbide nanoparticles as a reinforcing component. Good dispersion of nanoparticles in the matrix was verified by means of atomic force microscopy. The significant improvement in wear resistance was measured under an applied load in the millinewton range using a custom-made microtribometer, and in the newton range using ball-on-disk apparatus. Such a system can be applied in textile machines and elastic yarn tensioners for damping the longitudinal component of vibrations, largely influencing the quality of the fabric obtained.

Key words: *yarn tensioner, nanocomposite, nanoparticles, polymer substrate, silk prining, tribology tests.*

press release

Introduction

The dynamics of yarn tension is a crucial factor in many textile processes, determining both the process efficiency and quality of fabrics. It influences the tendency of yarn to break, particularly at high yarn speeds. Yarn vibrations also result in fabric inhomogenities and thus in its lower quality.

Currently, textile machines do not provide effective solutions for dumping yarn vibrations. It has been demonstrated [1] that the best results can be obtained by simply running yarn between finger pads. Therefore, it has been proposed to build a dumping element, mimicking human finger pads. The idea of such an element, consisting of a non-Newtonian medium contained in an elastic bag, is illustrated in ***Figure 1***.

This elastic element would press yarn against the metal plate of a tensioner, providing the stable yarn tension desired.

Taking into consideration the high yarn speeds and impurities present on its surface, the high wear resistance of the external bag wall surface is essential. The goal of the research presented in this paper is to design and test the idea of an antiwear protective layer for a soft, elastic bag, in the form of a thin nanocomposite layer, consisting of a hard epoxy resin matrix and superhard silicon carbide nanoparticles as reinforcing components. It is important to note, however, that during bending and straining, typical for target application conditions, such a hard continuous layer would easily produce multiple cracks and eventually detach from the elastic substrate.

We propose to address this issue by applying a well-defined noncontinuous hard pattern on the surface in the first place. Such a protective layer will be able to freely deform with the substrate and, if well adhering to the surface, should provide good resistance to detaching. The layer deposition technique chosen in this work is silk screen printing, a precise method for applying patterns to the surface. Another method of deposition was dip coating; the results obtained with this technique, less promising than the present ones, have been described in an another work [2].

Experimental

Materials

Commercial epoxy paint for silk screen printing, a mixture of Apollo C63 lacquer and glossy hardener Apollo C, was used as the matrix material. This paint was chosen for its rheological properties, adequate for silk screen printing, good chemical resistance and surface adhesion. The nanofiller used was superhard spherical silicon carbide (SiC), with a purity of 97% and average size of 20 - 30 nm.

The idea of a noncontinuous protective layer was applied and tested on model substrates: single crystal silicon wafers and commercial polyester high temperature film.

Outline of the experimental procedure

Nanocomposites were obtained by dispersing SiC powder in paint before

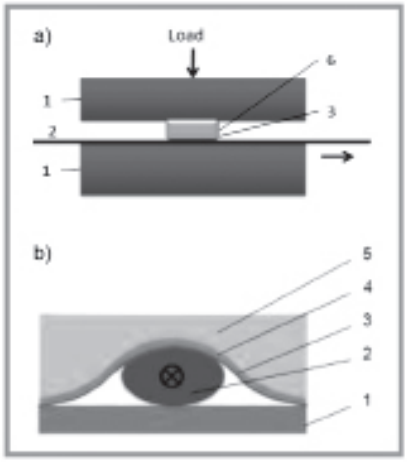

Figure 1. *Idea of the damping element in a yarn tensioner a) tensioner, b) blow-up of the friction point in a): cross-section: 1 – metal plates, 2 – yarn, 3 – protective, wear resistant layer, 4 – bag wall, 5 – damping medium, 6 – bag containing the non-Newtonian fluid.*